A NEW GENUS AND SPECIES OF ANT-ASSOCIATED COCCID (HEMIPTERA: COCCIDAE: MYZOLECANIINAE) FROM *CANTHIUM* LAM. (RUBIACEAE)

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The adult female and first-instar nymph of *Torarchus endocanthium* gen. et sp. nov. (Hemiptera: Coccidae: Myzolecaniinae) from Queensland, is described. This coccid is known only from inside hollow, swollen stems (ant domatia) of plants of the genus *Canthium* Lam. (Rubiaceae), where it lives as a trophobiont in the nests of ants of a *Podomyrma* species (Formicidae: Myrmicinae). The first-instar nymph has typical coccid features, but the adult female is unusual, being distinguished within the Coccidae by its multilocular disc-pores and microducts resembling bilocular pores on the dorsum, and rounded, projecting anal plates on the anterior edge of a setose bulge. □ *Coccidae, Formicidae, Rubiaceae, ant-plant association.*

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A new ant-plant association (Monteith, 1989, 1990) from marginal rainforest areas of coastal to central Queensland involves trees of the *Canthium odoratum–C. buxifolium* complex (Rubiaceeae) and ants of an undescribed *Podomyrma* species (Formicidae: Myrmicinae). The ant colonies occur within specialised swellings in the living stems (ant domatia) (Fig. 1), which the ants hollow out by perforating the wall and removing the pith. The ants never occur away from their host trees; likewise, the trees are rarely found without these ants. Monteith and co-worker Paul Flower established that the ants obtained their nutrition largely from scale insects, also called coccoids (Hemiptera: Coccoidea), living within the ant domatia (Fig. 1). The feeding stylets of these coccoids presumably tap the phloem of the host plant and the coccoids' excreta, called honeydew, is consumed by the ants. It is not known whether the ants ever eat the coccoids.

These coccoids of *Canthium* belong to two families - the Pseudococcidae (mealybugs) and the Coccidae (soft scale insects or coccids). The mealybugs are *Pseudococcus longispinus* (Targioni Tozzetti) and two undescribed, closely related species, probably belonging to *Crisicoccus* Ferris or *Paracoccus* Ezzat & McConnell. The undescribed mealybug species might be specific to the *Podomyrma-Canthium* association although they belong to a group with no known association with ants, whereas *P. longispinus* is cosmopolitan, polyphagous, and one of the most pestiferous mealybugs in Australia (Williams, 1985; Williams & Watson, 1988). The soft scale insects belong to an undescribed species of Coccidae with unusual morphology, suggestive of an obligate relationship with the ants. Individual adult coccids have their convex venter closely fitted into pits gnawed by the ants into the inner surface of the domatium. Their dorsum is ridged and covered in setae, and their anal area appears modifed to facilitate honeydew removal by ants. The eversible anal tube is strongly developed and surrounded by a pair of rounded, dorsally projecting anal plates so that the whole complex forms a prominent mound. These coccids have been collected only from ant chambers inside the stems of *Canthium odoratum* (Forster f.) Seemann and may be dependent on this ant-plant association,

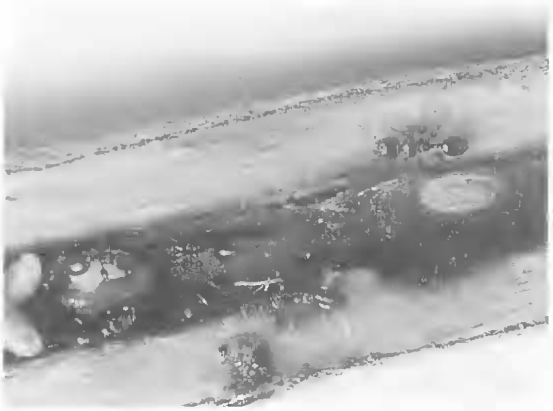

FIG. 1. Sectioned hollow stem of *Canthium odoratum* showing ant workers and larvae (*Podomyrma* sp.) on the right and an adult female of *Torarchus endocanthium* on the left.

although they are not found in all plants that house colonies of *Podomyrma*. To date, the coccids have been collected only in SEQ coastal areas and one more inland site, although the ant-plant association is more widespread. Where coccids are absent, the domatia house mealybugs, often in large numbers and sometimes of more than one of the above species. In older stems, the mealybugs mostly reside in the ant-gnawed pits but may feed anywhere within younger stems. Sometimes domatia house both coccids and mealybugs.

Scale insects have been reported previously from inside the swollen stems of Rubiaceae in Africa (Bequaert, 1922). Those collected with *Crematogaster laurenti* Forel (Formicidae: Myrmicinae) inside hollow stems of *Psydrax subcordata* (DC.) Bridson (formerly *Plectronia laurentii* De Wild.) from Zaire were described as *Hemilecanium recurvatum* by Newstead (1910). This species is morphologically very different from the coccid from *Canthium* in Queensland (types of *H. recurvatum* (BMNH) have been examined) and belongs to a different subfamily. In Australia, no coccids or mealybugs have been reported previously from *Canthium*, although species of *Myzolecanium* Beccari (formerly placed in *Cryptostigma* Ferris; see Qin and Gullan, 1989; Gullan, Buckley & Ward, 1993) and *Alecanopsis* Cockerell (Green, 1924) have been described from ant nests in living hollow stems of other plants. *Alecanopsis* and *Myzolecanium* belong to the same subfamily as the coccids from *Canthium* but are very different morphologically.

This paper describes the coccid from *Canthium*. Features of the adult female place it in the Myzolecaniinae Hodgson, 1994. It is atypical for a coccid in having both multilocular disc-pores and microducts resembling bilocular pores on the dorsum, and in having anal plates which are very rounded and dorsally projecting, together forming a mound when the anal tube is retracted (i.e. when the plates are closed). In most other coccids, each anal plate is triangular, posteriorly directed and lies level with the dorsal surface when the anus is retracted. Furthermore, in this new species the anal area is located on the anterior edge of a prominent bulge which bears very long setae in a central depression. The first-instar nymph is more typically coccid-like (Miller, 1991), except that each stigmatic cleft has only a single stout stigmatic seta. It differs in this regard from known first-instar nymphs of other Myzolecaniinae (Ray & Williams, 1980; Qin & Gullan, 1989; Sheffer & Williams, 1990).

METHODS AND ABBREVIATIONS

Terminology follows Hodgson (1994, 1995). To prepare adult females and nymphs as microscope slide-mounts, body contents were cleared in cold 10% w/v potassium hydroxide (KOH) solution overnight, the cuticle was stained in acid fuchsin in acid alcohol, dehydrated in 3 changes of absolute ethanol and 1 of absolute propan-2-ol and then placed in 3 changes of xylene prior to mounting in Canada balsam. Scale insects were prepared for scanning electron microscopy (SEM) after preservation and storage in 80% ethanol. Each specimen was dehydrated in a graded ethanol series, dewaxed in xylene, rehydrated through a graded ethanol series into distilled water, post-fixed in 1% aqueous osmium tetroxide, washed in distilled water and sonicated briefly to remove any black precipitate, critical point dried, glued onto a metal stub with nail varnish and coated with gold palladium under vacuum. Specimens were then examined and photographed using a Cambridge S360 SEM.

Abbreviations used for the depositories are: ANIC, Australian National Insect Collection, CSIRO, Canberra; BMNH, The Natural History Museum, London; QM, Queensland Museum, Brisbane. Each listed scale insect is mounted on a separate microscope slide, unless otherwise specified.

SYSTEMATICS

Torarchus gen. nov.

TYPE SPECIES. *Torarchus endocanthium* sp. nov.

DIAGNOSIS. Adult female with rounded-elongate elevations on dorsum in a definite arrangement; dorsal cuticle with both multilocular disc-pores and microducts resembling bilocular pores; anal plates rounded and projecting, situated on anterior edge of raised area of cuticle. First-instar nymph of typical coccid form, but with single stout seta per stigmatic cleft. All stages living in hollow stems of host plant attended by ants.

DESCRIPTION. Features believed to be taxonomically significant at generic level are highlighted. The species description provides the best summary of this monotypic taxon.

Adult female broader than long, with a row of rounded-elongate elevations or ridges dorsally on each side of midline, these become less apparent after slide-mounting; setae flagellate, clustered

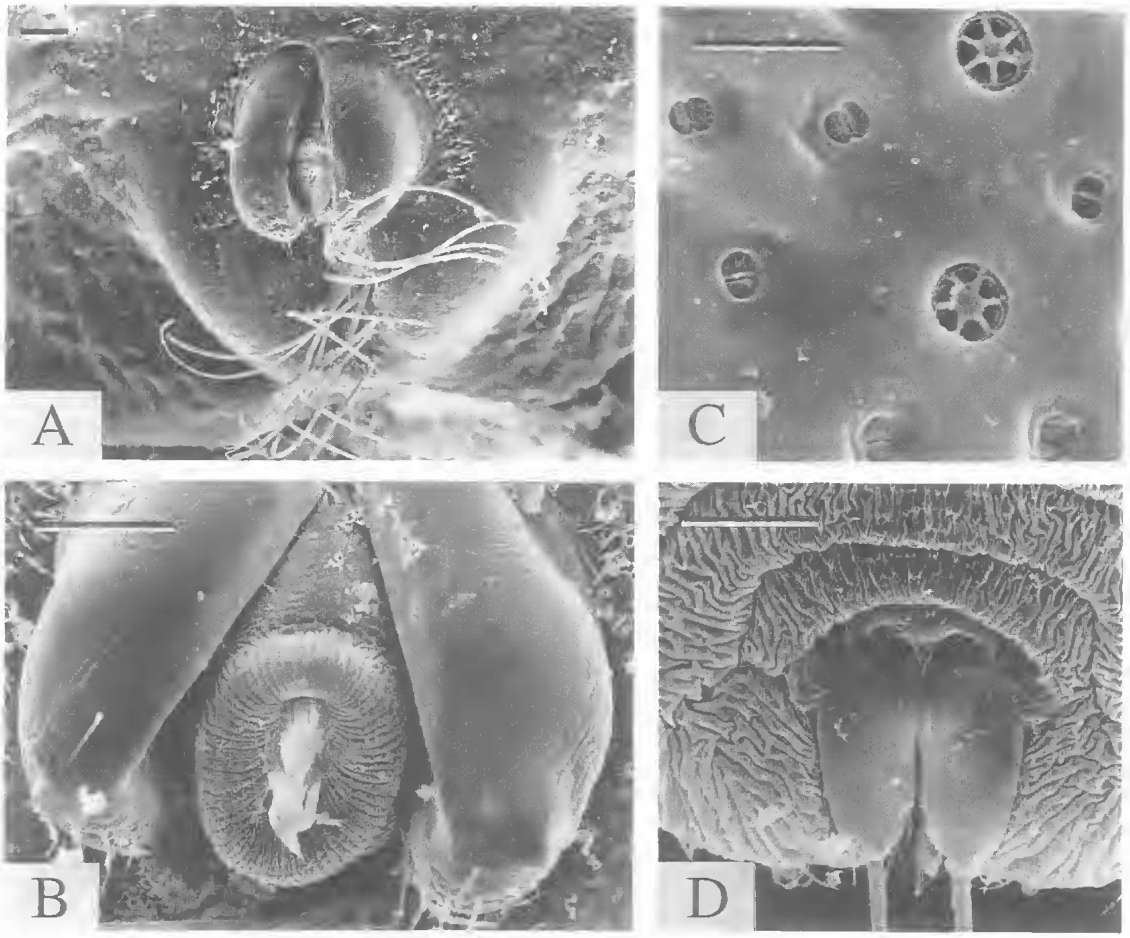

FIG. 2. SEMs of cuticular features of *Torarchus endocanthium*: A, anal area of adult ♀, showing rounded anal plates and long setae on raised area behind anus (scale 50 μm); B, enlargement of anal area of another adult ♀, showing anal plates and partially everted anus (scale 50 μm); C, multilocular disc-pores and openings of microducts on dorsolateral surface of adult ♀ (scale 10 μm); D, dorsal view of anal area of first-instar nymph, showing anal plates and rugose cuticle (scale 25 μm).

dorsally on ridges, in irregular double row marginally and sparsely scattered ventrally, but with a group of very long (1.5-2.5 times length of anal plates), robust setae posterior to anal plates on raised area; dorsal pores of 3 kinds: 1, disc-pores with 4-8 loculi, 2, microducts which resemble bilocular pores when viewed end-on in light microscope (Fig. 3h) and 3, simple pores; dorsal tubular ducts and dorsal tubercles absent; anal plates projecting and lobe-like with cluster of apical setae; spiracles much larger than legs; spiracular disc-pores present in bands between body margin and each spiracle, with 5 loculi; pregenital disc-pores with 5 or 6 loculi; ventral tubular ducts absent but small microducts scattered ventrally; eyespots absent; legs and antennae reduced.

First-instar nymph oval; derm with rugose sculpturing; dorsum lacking setae, pores, ducts and tubercles; anal plates elongate triangular with rounded angles; margin with row of slender setae, each stigmatic cleft with single stout stigmatic seta; venter with few setae on head and thorax, short setae in 2 submarginal rows on abdomen, longer setae in 2 submedial longitudinal rows on abdomen; antennae 6-segmented; legs well developed, fore legs each with single digitule.

COMMENTS. This genus shares several features with others of the Myzolecaniinae; for ex-

ample, *Cyclolecanium* Morrison, *Megasaissetia* Cockerell, *Neolecanium* Parrott and *Pseudophilippia* Cockerell also possess some form of dorsal pore or microduct with a bilocular appearance and that of *N. imbricatum* (Cockerell) even has an inner duct (Hodgson, 1994) similar to that of *T. endocanthium*. The dorsal ridges of *T. endocanthium* are of similar shape but different number and arrangement from those of *Coccus tumuliferus* Morrison (Morrison 1921), which is not a true species of *Coccus* Linnaeus (Coccinae) but undoubtedly a member of the Myzolecaniinae. Furthermore, the anal plates of *C. tumuliferus* are of somewhat similar shape to those of *T. endocanthium* but with different arrangement and number of setae; however, the dorsal pores and setae and ventral ducts of *C. tumuliferus* are very different from those of *T. endocanthium*. The presence of multilocular disc-pores and microducts resembling bilocular pores on the dorsum of *Torarchus* easily distinguishes it from *Akermes* Cockerell, *Alecanopsis* and *Myzolecanium*, which are the other genera of the Myzolecaniinae found in Australia; furthermore, it differs from *Myzolecanium* in having very shallow stigmatic clefts and from *Akermes* and *Alecanopsis* in having no stigmatic setae. *Torarchus* keys out in Hodgson (1994, pp. 91-92) to the couplet containing *Akermes* and *Alecanopsis*, but does not fit the description of either.

ETYMOLOGY. Latin *torus*, round elevation or bulge, Greek *archos*, anus; refers to the shape of the plates surrounding the anus and location of the anal area on a cuticular bulge.

Torarchus endocanthium sp. nov.
(Figs 1-4)

MATERIAL EXAMINED. HOLOTYPE, QMT13986, adult ♀, Qld, Mt Crosby, off Crosby Rd & Bunya St., 27° 32'S, 152° 48'E, 9.iv.1989, P. Flower. PARATYPES adult ♀♀ only, QLD: 7 adult ♀♀, same data as holotype; 1 adult ♀, 2 slides of first-instar nymphs, Mt Crosby, 18.viii.1988, P. Flower; 1 adult ♀, 1 slide of first-instar nymphs, Mt Moffatt Nat. Park, Kenniff's Lookout, 24° 55'S, 147° 59'E, 13.xii.1987, G. Monteith, G. Thompson & D. Yeates; 7 adult ♀♀, 3 immature ♀♀, 6 slides of first-instar nymphs, Auburn Gorge, SW Mundubbera, 25° 43'S, 151° 03'E, late March 1989, G. Monteith; 3 adult ♀♀, Keysland, 20 km NW of Wondai, late March 1989, G. Monteith.

Location of paratypes: 4 adult ♀♀ and 2 slides of first-instar nymphs in ANIC, 1 adult ♀ in BMNH, remainder in QM (QMT26022-26035).

DIAGNOSIS. As for genus.

DESCRIPTION. Adult ♀ (10 specimens measured). Live material. Body of young ♀ yellow, with sparse coating of white, powdery wax.

Mounted material. Body transversely oval, rounded on each side, 1.3-1.8 times wider than long, rather flattened but with elevated areas on dorsum; stigmatic clefts shallow; anal cleft fused. Length 1.5-2.6 mm, width 2.3-4.4 mm.

Dorsum. Derm membranous except for narrow crescent of sclerotisation around anterior margin of anal plates and light sclerotisation at margin in stigmatic cleft; with 7 radial ridges dorsally on each side of body, forming an elevated submedial area following curve of margin, with anteriormost and posteriormost ridges smallest; a rounded raised area lies posterior to anal plates (Fig. 2A) with central depression marking position of anal cleft. Dorsal setae flagellate, 15-100 μm long in submarginal areas and around anal plates, longer (70-150 μm) medially and clustered on ridges; a group of 13-26 very long (230-500 μm), robust setae posterior to anal plates on raised area. Dorsal pores of 3 kinds: 1, multilocular disc-pores 5.5-7.5 μm in diameter with 4-8 (mostly 6, Figs 2C, 3i) loculi, scattered in marginal and submarginal area; 2, microducts resembling bilocular pores (Figs 2C, 3h), 3-4 μm in greatest dimension, densely distributed over entire dorsum; 3, simple pores (Fig. 3f) 3-4 μm in diameter, scattered over dorsum. Preopercular pores absent. Dorsal tubular ducts absent. Dorsal tubercles absent. Anal plates lobe-like, rounded apically (Figs 2A, 2B, 3d), each 150-210 μm long, 110-150 μm wide when measured in natural position (distortion during mounting common); with 5-6 small setae apically on each plate. Anogenital fold with 2 pairs of setae in hypopygial position, a pair of larger setae at each corner of anterior margin and 1 pair laterally. Anal ring 58-68 μm in diameter, probably with 6 pairs of setae, 65-115 μm long, rather flattened (Fig. 3e), difficult to see when retracted inside anal tube (Fig. 2B).

Margin. Marginal setae flagellate (Fig. 3g), 25-150 μm long, in irregular double row around entire margin except absent in stigmatic clefts and posteriorly where fused anal cleft joins margin. Stigmatic clefts very shallow with small area of light sclerotisation; lacking stigmatic setae. Eyespots apparently absent.

Venter. Derm membranous; only abdominal seg-

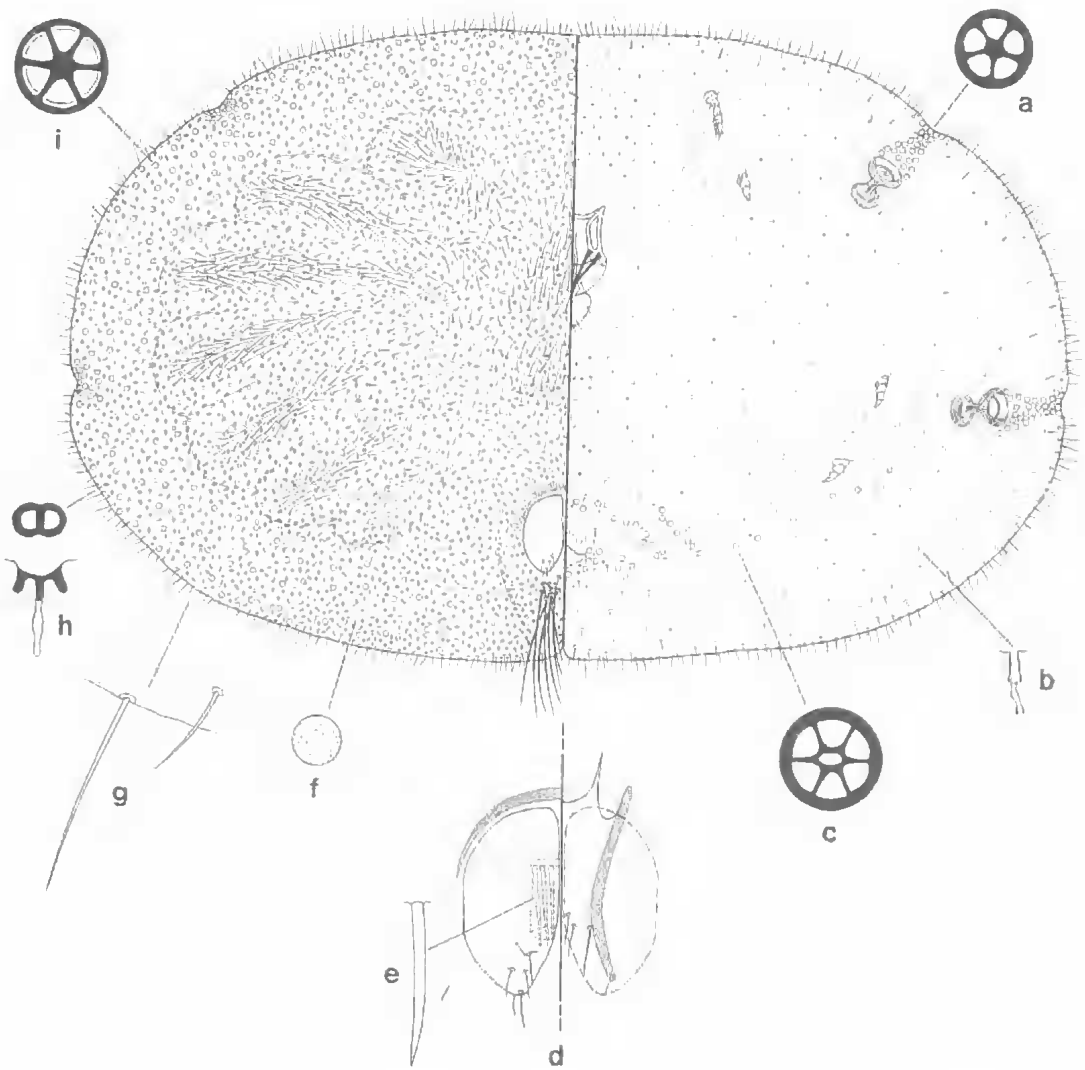

FIG. 3. Adult ♀ of *Torarchus endocanthium*. Enlargements: A, quinquelocular disc-pore from stigmatic furrow. B, ventral microduct. C, pregenital disc-pore with 6 loculi. D, anal lobes viewed dorsally (on left) with anal ring and anal ring setae indicated by dashed lines, and ventrally (on right) showing setae and supporting bar of ano-genital fold. E, anal ring seta. F, simple pore. G, marginal setae. H, lateral and end-on views of dorsal microduct. I, multilocular disc-pore.

mentation discernible. Ventral setae flagellate, 15-75 μm long, sparsely scattered. Pregenital disc-pores (Fig. 3c) 8-10 μm in diameter with 5-7 (mostly 5-6) loculi, distributed around vulva on posterior segments and in an irregular line reaching to metathoracic spiracle of each side. Stigmatic furrows each with quinquelocular disc-pores (Fig. 3a), 5-6 μm in diameter, in a band from margin to spiracle. No preantennal pores present. Ventral microducts (Fig. 3b) each with outer ductule 4-5 μm long and inner ductule with conspicuous innermost end, each microduct appearing as a small slightly oval pore when viewed end-on, scattered throughout venter. Ventral tubular ducts absent. Spiracles well developed, with conspicuous muscle plate to each peritreme; anterior spiracle plus peritreme 150-200 μm long, 110-135 μm wide; posterior spiracle plus peritreme 150-200 μm long, 120-140 μm wide. Legs reduced, each 90-130 μm long, trochanter fused with femur, fusion of tibia and tarsus partial to complete; each claw small, without denticle;

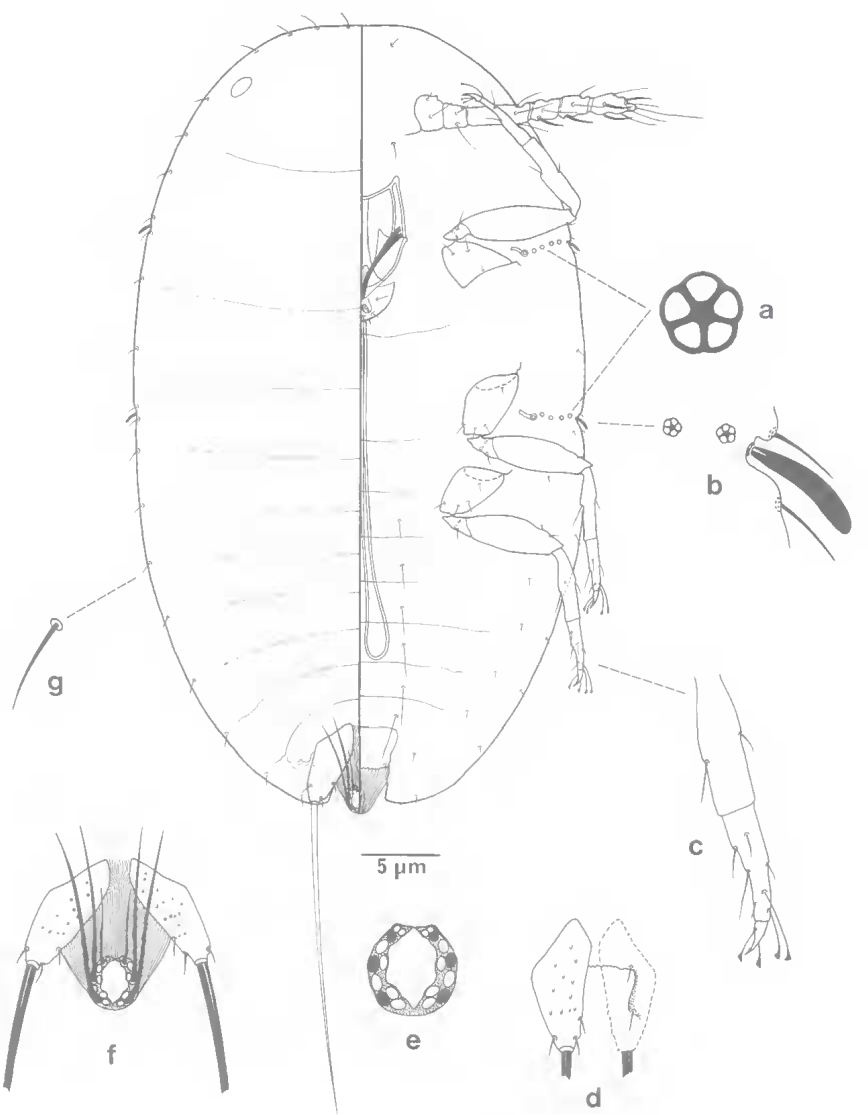

FIG. 4. First-instar nymph of *Torarchus endocanthium*, with anus everted. Enlargements: A, quinquelocular disc-pore from stigmatic furrows. B, stigmatic area with stigmatic seta in cleft, 2 marginal setae and quinquelocular disc-pores. C, apex of hind leg showing digitules. D, dorsal (on left) and ventral (on right) views of anal plates. E, anal ring with setal positions indicated by blackened spots; F, dorsal view of anal lobes and everted anal ring; G, marginal seta.

claw digitules longer than claw but shorter and broader than tarsal digitules; tarsal digitules 22-25 µm long. Antennae reduced, with 5-6 segments at most, segmentation often indistinct; total length 95-150 µm; with fleshy setae 13-25 µm long on apical segments and flagellate setae 15-65 µm long on all segments. Clypeolabral shield 350-390µm long, 270-320µm wide. Labium 1-segmented, 140-150 µm long, c.150 µm wide.

First-instar nymph (10 specimens measured). Mounted material. Body oval, 463-560 µm long, 270-315 µm wide. Derm membranous throughout but with rugose sculpturing dorsally and ventrally, most clearly visible in SEM (Fig. 2D). Segmentation not readily apparent (but obvious in whole nymphs under SEM).

Dorsum. Setae, pores, ducts and tubercles absent.

Anal plates (Fig. 4d) elongate triangular with rounded angles, 40-48 μm long, 15-24 μm wide; anterolateral margin 22-26 μm long, posterolateral margin 25-30 μm long; dorsal surface with scattered microspines. Each plate with 4 dorsal setae, 3 on apex of plate, 1 on mesal margin; median seta on apex robust, 190-225 μm long, about half length of body. Ano-genital fold with 1 pair of anterior margin setae and 1 pair of lateral margin setae. Anal ring (Fig. 4e) approximately circular, 18-22 μm in diameter, with about 14 irregularly shaped pores and 6 setae, 45-68 μm long, with 2 setae distinctly shorter and more slender than other 4 (Fig. 4f).

Margin. Marginal setae (Fig. 4g) 10-15 μm long, slender, tapering to a point, usually curved, pointing in posterior direction, distributed as follows: 8 around head between anterior stigmatic clefts, 4 between each pair of stigmatic clefts, and 18 on abdomen. Stigmatic clefts moderately developed (Fig. 4b), each with single stout stigmatic seta 10-16 μm long, bordered by 2 slender marginal setae, 1 anterior and 1 posterior to each stigmatic seta. Eyespots present just above level of antennal scape.

Venter. Ventral body setae slender, of 2 lengths: submarginal setae short, 2-5 μm long, in 2 longitudinal rows each of 7 on each side of abdomen (2 pairs of setae per segment), 1 seta between anterior and posterior stigmatic clefts and 1 pair at apex of head; submedial setae 20-45 μm long, in 2 longitudinal rows of 6 each on abdomen (1 pair per segment), setae longer posteriorly, and 1 pair between antennae. Spiracles plus peritremes 15-21 μm long, 6-10 μm wide. Stigmatic furrows each with quinquelocular disc-pores (Fig. 4a), 2-3 μm in diameter, in single row; anterior spiracular disc-pore bands each with 4-6 pores; posterior spiracular disc-pore bands each with 4-5 pores. Other pores and ducts absent. Legs well developed, 210-245 μm long, without tibiotarsal sclerotisation or free articulation; 1 or a few flagellate setae on each segment; 2 knobbed claw digitules (Fig. 4c) per leg; 2 knobbed tarsal digitules (Fig. 4c) per leg, except fore legs each with only 1 digitule; tarsal claw with small denticle. Antennae well developed, 6-segmented, 130-160μm long; segment III longest, 33-45 μm; 5 fleshy setae (1 on IV, 1 on V, 3 on VI), 13-25 μm long, and about 15 hair-like setae, 10-53 μm long. Mouthparts with clypeolabral shield 83-90 μm long, 63-77 μm wide; labium 1-segmented, 30-36 μm long, 45-50 μm wide, with 4 pairs of setae; stylets looped, total length 500-660 μm.

COMMENTS. The first-instar nymphs of most Coccidae possess 3 stout stigmatic setae per stigmatic cleft. The nymph of *T. endocanthium* has only one differentiated stigmatic seta per stigmatic cleft (presumably homologous with the median stigmatic seta of other coccids). The 2 slender setae that border each stigmatic seta in nymphs of *T. endocanthium* appear identical to the remainder of the marginal setae but may be homologous with the 2 stout lateral stigmatic setae that normally accompany the longer median stigmatic seta in other coccids.

ETYMOLOGY. Greek *endon*, within or inside, with the name of the host plant *Canthium*.

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